

Amendment under 37 C.F.R. §1.116
Serial No. 10/662,384
Attorney Docket No. 031111

REMARKS

Claims 1-14 are currently pending. Claims 1-3 and 7-13 have been withdrawn from consideration. Claim 14 had been added in the amendment of March 17, 2005. Claim 4 is amended herein. Support for this amendment is found at lines 24-25 on page 13 of the present specification.

Applicants' Response to Claim Rejections under 35 U.S.C. §103(a)

The Office Action has maintained the rejection of claims 4-6 under 35 U.S.C. §103(a) as being unpatentable over **Umeda** in view of **Wristers/Karasawa**. In response thereto, applicants have amended claim 4 to more distinctly claim the subject matter regarded as the invention. Specifically, applicants have amend claim 4 so as to include the limitation that the oxynitride film has a thickness of 3nm or thinner.

(a) Limitations of the claims are not taught by the cited prior art

Applicants respectfully submit that the limitation of amended claim 4 is not taught or suggested by the cited references. **Umeda's** Fig. 5 shows the depth direction profiles of nitrogen. **Umeda** states, in lines 46-50, "It can be seen that the silicon oxynitride film obtained by the method of the first embodiment has nitrogen localized at an interface portion between the silicon substrate and the silicon oxynitride film." In the depth range 1 to 3 nm, the nitrogen profile shows a peak. If the oxynitride film has a thickness of 3 nm or thinner, it cannot be maintained that the nitrogen is localized at the interface between the silicon substrate and the oxynitride film. Namely, one of skill in the art will recognize that **Umeda** excludes the thickness range thinner than 3 nm from consideration.

Karasawa's oxynitride film 2 has a thickness of 80 of 100A (8 to 10 nm) (see col. 3, line 5). When the oxynitride film has a thickness of 3 nm or thinner, the oxynitride film dominantly includes a structural transition region. Therefore, if the oxynitride film has a thickness of 3 nm or thinner, **Karasawa's** method (ion implantation) does not provide the claimed structure.

Further, none of the prior art teaches or suggests the limitation of the existence ratio at 20% or smaller. The Office Action maintains that the specification contains no disclosure of either the critical nature of the claimed range or any unexpected results arising there from. However, applicants respectfully submit that Fig. 6 and the disclosure at page 12, line 23 to page 13, line 17 and page 16, lines 15-19, demonstrate the criticality of the claimed range. Wherefore, in light of the amendment to claim 4 and the above remarks, applicants respectfully request favorable reconsideration.

(b) The cited prior art would not be combinable to one skilled in the art

Additionally, Applicants respectfully assert that it would not have been obvious to one skilled in the art at the time the invention was made to modify **Umeda's** device by incorporating the invention as taught by **Wristers**. **Umeda** states, in lines 58-61 at column 1, "it was found that nitrogen in silicon oxynitride film formed by this method localizes at an interface between the silicon substrate and the silicon oxynitride film." In contrast, **Wristers** states, in lines 8-12 at column 7, "As shown in Fig. 4, the concentration of nitrogen atoms 22 in resulting oxynitride layer 20 is fairly uniform not only across the frontside surface, but, more importantly, throughout the cross-sectional plane or profile) of oxynitride layer 2." and, in lines 22-25 at column 7, "Advantages in having a uniform distribution of nitrogen are manifold, some of which are to

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control boron diffusion and hot electron trapping therein.” Namely, **Umeda**’s structure and **Wristers**’ structure are contradictory to each other.

There is insufficient motivation in the art to make the combination because there is no recognition in the prior art that superior electrical characteristics are obtained when the claimed NSi_3 structure is 20 % or smaller. Hence, one skilled in the art would not be motivated to utilize the process of Umeda to form the Wristers/Karasawa NSi_3 layer then test and adjust the process to the gate insulating layer is the claimed existence ratio of the NSi_3 structure of 20 % or smaller. Therefore, one of ordinary skill in the art would not have been motivated to combine the teachings of the references. Wherefore, applicants respectfully request favorable reconsideration.

(c) The combination of the cited references would not result in the claimed invention

Applicants further respectfully submit that the teachings of **Karasawa** and **Wristers** would not result in the claims’ $\text{NSi}(3)$ structure. The Office Action asserts, in paragraph 3 on page 2: “It is held, absent evidence to the contrary, that forming a silicon oxynitride film on a surface of a semiconductor substrate and performing ion implantation of nitrogen atoms to the oxynitride layer would result in the claims $\text{NSi}(3)$ structure.” Applicants respectfully submit that such evidence is located within the teaching of the prior art as contrasted to that of the present invention.

In **Karasawa**’s method, nitrogen atoms are ion-implanted into the oxynitride film. **Karasawa** states, in paragraph [0010], “Nitrogen atoms ion-implanted will be activated or introduced in the network of the oxynitride layer by subsequent thermal history.” In contrast, in

the sample A in the embodiment of the present invention, nitrogen atoms are introduced by exposing the silicon oxide film to nitrogen plasma (page 8, lines 23-25). In the same samples B to F, nitrogen atoms are introduced by heat treatment performed in NO gas (page 9, lines 1-3).

For example, **Karasawa's** method increases a number of nitrogen atoms in the oxynitride film. If the number of nitrogen atoms increases, a number of subject nitrogen atoms as defined in claim 4 is also likely to increase. Namely, both the denominator and the numerator in the existence ratio as defined in claim 4 increases. There is no teaching or suggestion whether the existence ratio increases in **Karasawa**.

As described above, **Karasawa's** method and the present embodiment method are completely different from each other in process. Applicants respectfully submit that one skilled in the art would not be able to speculate that forming the oxynitride film by **Karasawa's** method would result in the claimed NSi(3) structure.

Further, in **Wristers' method**, the oxynitride layer 20 is formed at a pressure from 2×10^5 Pa to 10×10^5 Pa (col. 7, lines 6-8). In contrast, in the present embodiment, the oxynitride films are formed at pressures of 665 Pa and 2669 Pa (page 9, the first paragraph). **Wristers' method** and the present embodiment method are eminently different from each other in pressure condition. It cannot be speculated that forming the oxynitride film by **Wristers' method** would result in the claimed NSi(3) structure.

(d) Limitations from Claim 6 are not taught or suggested in the prior art

Regarding claim 6, the Office Action asserts that **Wristers** (col. 3, lines 52-65 and col. 4, lines 11-26) discloses that the step of forming the silicon oxynitride film comprises steps of:

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forming a silicon nitride film on the surface of the semiconductor substrate; and oxidizing the silicon nitride film.

According to **Wristers'** description, nitrogen is incorporated into a pre-existing oxide. Namely, in this step, SiO₂ is changed to SiON. After that, the SiON is re-oxidized. In contrast, in claim 6, SiN is oxidized. Namely, SiN is changed to SiON. Wherefore, applicants respectfully submit that the limitation of claim 6 is not disclosed by **Wristers**.


In view of the aforementioned amendments and accompanying remarks, Applicants submit that the claims, as herein amended, are in condition for allowance. Applicants request such action at an early date.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney to arrange for an interview to expedite the disposition of this case.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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